River Crossing Challenges

- Permitting
- Overhead design considerations
- Foundation design considerations
- Construction
Project Facts – Entire Project

- $485 million total
- 156 miles
- 6 substations
- 1,032 structures
- 1,143 foundations
- 1,200 miles of conductor
- 130,000 yards concrete
Project Facts – River Crossing

- $17.9 million
- 1.3 miles
- Triple circuit
- 5 structure locations
  - 2 accessible only by barge
- 15 pile caps
<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>Early Studies</td>
</tr>
<tr>
<td>2005</td>
<td>Development</td>
</tr>
<tr>
<td>2006</td>
<td>MN Need</td>
</tr>
<tr>
<td>2007</td>
<td>Public Input</td>
</tr>
<tr>
<td>2008</td>
<td>WI Need and Routing</td>
</tr>
<tr>
<td>2009</td>
<td>MN Routing</td>
</tr>
<tr>
<td>2010</td>
<td>Federal Review (RUS)</td>
</tr>
<tr>
<td>2011</td>
<td>Permitting</td>
</tr>
<tr>
<td>2012</td>
<td>Construction</td>
</tr>
</tbody>
</table>

Timeline:

- **Early Studies** (2004-2005)
- **Development** (2006-2007)
- **MN Need** (2008)
- **Public Input** (2009-2010)
- **WI Need and Routing** (2011)
- **MN Routing** (2012)
- **Federal Review (RUS)** (2013-2014)
- **Permitting** (2015)
- **Construction** (2016)

Timeline events:

- **MN**
- **WI**
- **River Crossing**
**USFWS Concerns:**
- No new crossings, only minor expansion of existing crossings
- No definition of “minor”
- Balance bird and wetland tree clearing

**DNR and State Concerns:**
- No new crossings of river
- Bird impacts
- Utilize existing corridors to river

**Possible end point subs**
Permitting: Project Approach

- Listen to concerns
- Show alternatives
- Be flexible
- Provided 5 designs
  - Tall and narrow
  - Short and wide
  - Combinations of both
  - Underground
Approved Alternative

► 345/161/345 kV design
► Narrow and vertical in refuge
  ► Minimize wetland tree clearing

► Flat and wide across river
  ► Minimize threat to birds

► ROW width: 150 to 300 feet
Permitting Takeaways

► The best design is the one that gets a permit

► Sometimes it is better to be lucky than good

► You make your own luck (Luck is where preparation meets opportunity)
Design Challenges:

Thread the Needle

1,800 feet span

92 foot clearance requirement
Corps of Engineers

200 foot Max height

1,800 feet span

3 bundle, Canvasback ACSS 954, HS285 core
(comparis to 2 bundle, Cardinal ACSS 954 TW on main line)
Design Challenges:

Constructability

- Eliminated two structures to reduce cost, ease construction
- Tried to eliminate island structures
- Deadends inland: shorter poles, more accessible
- Heavy lift helicopter design at river channel in case river channel froze early.
Island Erosion 1958 - 2010

400 feet island loss in 52 years
Harden Against Extremes of River

- Bridge design firm Hanson Professional Services
- Hydraulic study by Power Engineers

Design considerations

- Poor river bottom soils
- Assume island erodes away -- per hydraulic study and aerial photos
- Scour – to 43 feet at main channel; river channel migration inland
- Floods – stems to 500 foot flood
- Ice impact – per MnDOT policy, using 18” thick ice with 32 ksf crush force
- Stream forces with debris impacts – per AASHTO Bridge Design Manual
  - Assumes 45 foot wide, 5-10 foot deep raft of debris at 100 year flood level
- Runaway barge impact not considered
Pile Cap Layout

4 pole structure
22’ x 22’ each
4 x 4 pipe array each

3 H-frames
22’ x 50’ each
4 x 9 pipe array each

3 pole deadend
36’ x 80’
5 x 12 pipe array
Pile Cap Facts

► 15 individual foundations

► Pipe piles
  ► 356 – 16” pipes, driven 50 to 130 feet deep
  ► 35,000 (6.5 miles) total pipe used

► Sheeting and rebar
  ► Structural grade sheet piling integral to foundation – driven to 55 feet
  ► 66,000 square feet sheet pile
  ► 18,000 ¾” studs
  ► 750,000 pounds rebar

► Concrete
  ► 5 to 6 foot thick concrete caps
  ► 4,400 yards concrete
    (2,000 yards delivered by barge)
Construction

► Line and general contractor – Xcel Energy

► Foundations – JF Brennan
Construction

- Scheduled July to February
  - Typical low water
  - Avoid eagle nesting season

- Our experience
  - Unseasonable summer floods
  - Silted river channel
  - Iron worker shortage
  - Concrete shortage
  - Eagle on nest
  - 35% increase in pipe pile requirement
Construction
Construction
River video
Q & A – CapX2020 River Crossing

- Grant Stevenson – project manager
- Will Pim – principal engineer
- Todd Obermoeller – line design lead, Power Engineers